Interim Stormwater Consultation Approach

This joint Federal Highways Administration (FHWA) and Washington State Department of Transportation (WSDOT) approach consists of grouping projects into three levels of consultation effort depending on the potential effects of the stormwater runoff associated with the project. Level One Consultations are for projects that will result in no net increase in pollutant loading and will not result in base flow, duration and peak flow alterations. Level Two Consultations are for projects that may result in some discountable level of effect to either: 1) pollutant loading or peak flow; 2) duration or base flow; or 3) both. Level Three Consultations are for those projects that will result in a measurable effect to: 1) pollutant loading or peak flow; 2) duration and base flows; or 3) both.

The purpose of grouping projects by their potential stormwater effects is to establish the level of analysis necessary to complete ESA consultation. The informational needs addressed in each level focus on the associated stormwater assessment methodology. Standard baseline information on existing conditions and effects of the project are to be included in the project's Biological Assessment (BA) and are not identified as information needs in this guidance. This stormwater guidance will be updated as needed and will be available on the WSDOT Environmental website on the Fish and Wildlife Page.

Projects that do not have the ability to have stormwater effects on listed species or proposed or designated critical habitat due to location or absence of the species and habitats do not have to follow this guidance. But they are expected to include stormwater as part of the project description and document the lack of effects on listed species in the effects analysis.

Level One Stormwater Consultations:

Projects that have no effect on listed species due to stormwater runoff associated with the creation of new impervious surface.

Standard: Projects must result in no net increase of pollutants to the receiving waters AND must have no effect on flow in receiving waters.

For no-net increase of pollutants:

- Projects that remove at a minimum an equivalent or greater amount of existing impervious surface than is created, and/or.
- Projects that treat more existing impervious surface (i.e. retrofit) than created and treated (resulting in a net reduction of pollutant loading).

For no effect on flow in receiving waters the project must:

- In accordance with the requirements of the HRM (for new impervious surface):

    - Infiltrate all runoff, and/or.
    - Discharge to flow control exempt waterbodies, (Currently USFWS is only comfortable with Puget Sound, Columbia River, Lakes Sammamish, Silver, Union, Washington and Whatcom. This issue still needs to be resolved.) and/or.
    - Disperse all runoff, without discharging runoff either directly or indirectly through a conveyance system to surface waters, and/or.
    - Replace lost hydrological functions by restoring upland, wetland, riparian and/or floodplain habitats within the affected watershed(s). This concept will require some work with the Services and Ecology before we can sue it.

BA Content:

<u>Performance Standards to be included in the BA</u>:

1. The project will result in no net-increase in pollutant loading.
2. The project will not adversely impact existing base flows.
3. Project-generated runoff will not result in stream channel erosion rates beyond that characteristic of pre-project conditions.

<u>Effects Analysis</u>

- Focus on the effects of construction activities and location of stormwater BMPs.
- Include description of net-new impervious surface area, BMP treatment methods, especially flow control (i.e., infiltration and dispersion), and how the project's net-new impervious surface area meets the Level One standards. The project must be able to document a no net-increase in pollutant loading as a result of retrofitting existing pollution generating impervious surfaces. Since the pollutants of concern are dissolved metals, the project may need to retrofit sufficient existing untreated impervious surface to insure that the project will result in no net-increase in metals loading to any receiving waters that contain listed fish or designated critical habitat. The amount of retrofit is to be determined by BMP effectiveness.

  Use the following calculation to assess on how much stormwater treatment of existing untreated impervious surface, if any, may be necessary to maintain the annual pollutant loading baseline:

  > *Annual effluent metals load = influent metals load – (metals load reduction achieved from infiltration + metal load reduction achieved from runoff treatment)*

If the annual effluent metals load is greater than zero, retrofit of existing impervious surface would be necessary to achieve the no-net increase in loading standard.

Annual effluent loads are provided in Table 1 below. The information on metals load reduction from infiltration is found in the ESA stormwater checklist.

Table 1. Annual pollutant loads from untreated and treated highway surface in lbs/acre. (from the WSDOT Environmental Procedures Manual (EPM) Exhibit 431-4, page 1 of 4)

Pollutant	Mean Load from untreated surfaces	Mean load from treated surfaces based on mean BMP effectiveness
Total Suspended Solids	878 (range 350-2000)	41 (range 40-42)
Total Copper	0.2 (range 0.1-0.3)	0.05 (range 0.045-0.055)
Total Zinc	1.1 (range 0.5-1.8)	0.26(range 0.23-.29)

Based on the above table, TSS removal is highly effective, with 95% removal. Removal of copper and zinc is approximately 75%. In order for a project to avoid any increase in pollutants to receiving waters, retrofitting of existing, untreated impervious surface should be at 133 %. In other words, a project would complete stormwater retrofit on 1.33 acres of untreated existing impervious surface for every acre of new impervious created.

Note that the BMP effectiveness data in Table 1. is based on basic treatment BMP's designed to the 1995 Highway Runoff Manual (HRM). BMPs listed in the 2004 HRM are expected to be much more effective.

- WSDOT and FHWA will develop performance standard language on maintaining or reducing pollutant-load levels in receiving waters and maintaining or enhancing base flows.

Level Two Stormwater Consultations:

Projects that have a discountable effect on listed species due to stormwater runoff associated with the creation of new impervious surface.

This level includes projects that either cannot or elect not to use the performance standards associated with Level One Consultations due to their project specific circumstances. These circumstances can include location, amount of net-new impervious surface created, retrofit levels, treatment levels, baseline conditions of the receiving waterbody, and/or presence or absence of species or effects. These projects require a detailed level of analysis beyond that proposed for the Level One Consultations, but the analysis does not require the extensive modeling associated with the Level Three Consultations to support the effect determinations.

Standard: Projects result in discountable effects to listed species and critical habitats from the stormwater runoff associated with the creation of new impervious surface.

Examples of project types that are appropriate for this level of analysis include:

- Projects able to retrofit some existing impervious surface, but not to the level that achieves a no net-increase in pollutant loading.

- Projects able to meet the no net-increase in pollutant loading, but are unable to fully attenuate flow by discharging to a flow control exempt waterbody, or complete infiltration or dispersion.

- Projects discharging stormwater runoff to receiving waters where listed species are less likely to be present and or effected (e.g., in a bull trout FMO area).

- Projects adding minimal impervious surface and discharging to waterbodies that are properly functioning.

BA Content:

The analysis will utilize existing data and will be based on a habitat-level of effects. It will focus on net-new acres of impervious surface and stormwater treatment levels. The BA will address the effects of the project on the baseline of the receiving waters. Modeling of average annual pollutant loading is not proposed as part of this analysis, however it may be necessary on a gross scale to assist in reaching an effect determination.

<u>Project Description and Baseline Information for Stormwater[1]</u>:

1. Determine the baseline (pre-project) runoff treatment and flow control. Using existing information obtained from the HRM's Endangered Species Act Stormwater Design check list (ESA checklist) provided by the project office, determine:
    a. How much net-new impervious surface there is in the project area (note that this information may be provided on a threshold discharge area basis)?
    b. How it is being treated, what BMP's are in place, if any?
    c. Describe where the discharge points are in terms of location and, if applicable, the receiving waterbody. For discharges to waterbodies, determine if the receiving water is on the HRM's flow control exempt list.

[1] Note that additional baseline informationprovided by the ESA checklist, species and habitats present in the action area are to be included in the BA along with a complete description of the project effects including clearing, grading and new impervious surface, etc..

d. Address the pollutants of concern. Currently the Services have requested that the following be analyzed: Total suspended solids (TSS), copper (usually analyzed or reported as total copper, but the dissolved portion is what is of concern to the Services – the particulate part tends to settle out and is not considered available.), zinc (as total zinc, with the dissolved portion being the issue of concern versus the particulate parts which settle out), lead (lead levels have dropped greatly since the introduction of unleaded gasoline), cadmium (which is often not detected in highway runoff. It is also reported as solid or dissolved.), chromium, and Polycyclic Aromatic Hydrocarbons (PAH's), which are a solid and are expected to be removed through the removal of TSS's. Information on other pollutants normally found in highway runoff can be found in Exhibit 6-1 of WSDOT's 2005 NPDES Progress Report for the Cedar-Green, Island-Snohomish, and Southern Puget Sound Water Quality Management Areas (NPDES Progress Report) (September 2005). Several years worth of monitoring reports are available at: http://www.wsdot.wa.gov/environment/wqec/wqec_npdes.htm.

WSDOT has monitored for lead, chromium, and cadmium in the past and has generally not found these pollutants in untreated stormwater runoff at levels high enough to detect. Current monitoring data collection completed by WSDOT does not include sampling for these metals.

The Services are also requesting information on PAH's. WSDOT has not monitored for PAH's in Washington State. Caltrans has monitored and found that it is rarely detected in untreated runoff and when detected is at levels below standards.

Based on this information the following standard language should be placed in each BA concerning lead, chromium, cadmium and PAH's.

WSDOT has monitored its untreated stormwater runoff in 2003 to determine what metals were present. Lead was discovered at very low levels or was undetected in some samples. Lead levels have decreased over time with the elimination of lead from gasoline and is no longer monitored for by WSDOT .

Both chromium and cadmium were discovered in very low levels in WSDOT stormwater sampling date in 2003 and 2004. Chromium was detected at levels below the statewide background levels and Puget Sound background levels. Cadmium was not detected in a number of samples and was detected at or below state background levels with the exception of one location in 2003. Since detected levels were so low, monitoring for these two metals is no longer conducted.

PAH's in the aquatic environment result in part from atmospheric deposition. Once deposited on the highway, it becomes one of the solids that are transported by stormwater runoff. WSDOT has not monitored for this substance in stormwater and thus has no data on what levels may or may not be detected in untreated runoff. The term PAH refers to a group of more than a hundred different compounds. PAHs rise from incomplete combustion, largely from burning fossil fuels and municipal waste but also from natural sources such as forest fires and volcanos. The primary mode of PAH release is atmospheric (from which particulates fall into the water), though some PAHs enter directly into surface waters from industrial and wastewater treatment plants. Oil spills can directly introduce PAHs into the water. Another source of PAH is coal tar sealants. It is extremely expensive and time-consuming to determine the source of specific PAH compounds. Untreated runoff monitored by Caltrans indicated that PAHs are either not detected or are well below standards. PAH compounds readily attach to soil and other solid particles. WSDOT stormwater BMPs are highly effective (95% or greater effectiveness) at removing solids. Thus between the low levels detected by Caltrans and the effectiveness of the BMPs at removing solids, PAHs are not expected to be a concern in WSDOT stormwater runoff.

e. Predict the effectiveness of the existing runoff treatment (e.g., what percentage of TSS, and heavy metals like copper (dissolved), and zinc (dissolved) are expected to be removed ? Include oil reduction if the project will trigger oil control requirements.). Evaluate the most current WSDOT NPDES Progress Report along with previous years monitoring reports to determine the potential effectiveness. Be aware that these reports present BMP effectiveness in terms of percentages (concentration of constituent going into BMP/concentration of constituent coming out of BMP). Therefore "effectiveness" measured in this way can increase or decrease with a wide variety of variables that impact stormwater quality. This prediction will be a very rough estimate. Remember that BMPS constructed to the 2004 HRM (or later) are expected to be more efficient than the BMP's that were monitored. The Department of Ecology has established performance goals for runoff treatment BMP's. These goals can be found in the HRM.

f. To the extent possible with available data, determine the baseline conditions of the receiving waterbodies. This step may already be completed for the baseline evaluation of waterbodies in the action area. Gather available information on their size/volume, flow rate, chemistry (e.g. hardness) and background concentrations of pollutants of concern relative to the runoff discharge volume and pollutant concentrations. If available, information on benthic invertebrate communities can be included. Gather information on other potential stressors such as temperature, other potential pollutants such as pesticides, dissolved oxygen, etc. This data may not be available for most waterbodies of interest. If there is no data available, you will not be unable to document the baseline in the receiving body.

Potential information sources include Department of Ecology 303(d) list, the Limiting Factors Analysis by Washington State Conservation Commission, and from local agencies. Additional water quality information may be available from the Environmental Protection Agency and the United States Geological Survey. Many data sources are available including a DOE publication on Background Soil Metals Concentrations for Washington State, Publication #94-115. When selecting data sources, strive to utilize data that has been quality controlled.

Effects Analysis

1. Determine what the stormwater impacts of the project are :
Using information obtained from the project office (information in the ESA stormwater checklist should be provided), and the baseline information gathered for the BA determine:

a. The total amount of net-new pollution generating impervious surface created in the project area.

b. The amount of existing pollution generating impervious surface that will be retrofitted in the project area.

c. Describe what runoff treatment BMPs have been selected for use on the project and estimate the load reductions for pollutants of concern. Insight to BMP pollutant effectiveness for various pollutants can be found in the Chapter 6 of the 2005 NPDES Progress Report (https:\\www.wsdot.wa.gov/environemtna/wgec/docs/2005 NPDES.pdf). (Notice that there are a lot of caveats and nuances regarding BMP effectiveness. For example, load removal effectiveness can depend on the form of the pollutant (i.e., solid or dissolved), the concentration of the pollutants flowing into the BMP, particle size distribution of the influent, volume of the influent, volume infiltrated, etc. Furthermore this data is collected from BMP's built to old design standards. While the BMPs built to current standards are presumed to work more effectively (including the introduction of enhanced treatment BMPs for dissolved metals removal), insufficient time has passed to allow such BMP's to be adequately evaluated. Thus any pollutant loading estimates based on this data will likely underestimate the pollutant load reduction effectiveness of BMPs designed to current standards. All of these considerations need to be factored in.) Remember that BMPs are not as effective at removing dissolved metals, as they are suspended solids.

There is also BMP effectiveness data in the EPM Exhibit 431.4. It is important to recognize that the BMP effectiveness data in the 2005 EPM are based on basic treatment BMPs designed to the 1995 HRM standards.

The Department of Ecology has established performance goals for the BMP's in the HRM, for some pollutants of concern.

2. Identify the receiving waterbodies and determine how much runoff may be discharged to each:

    a. Use the ESA Stormwater checklist to determine the flows that may be generated by examining how much net-new impervious surface will be created by the project. Also, describe the level of runoff treatment and flow control employed. Some projects may result in no net-increase of pollution generating surfaces. Other projects may be using 100% infiltration.

    b. Determine under what conditions, if any, will a storm event result in a discharge to a receiving water. This will be the design storm for runoff treatment BMPs employed, either flow-based and/or volume based (e.g., wetpools and infiltration facilities). Under what conditions, if any, will the storm event result in a discharge to the receiving water (i.e., the design storm? Infiltration BMPs will not result in a direct discharge to any receiving waters unless an extreme storm event (i.e., one that exceeds the design storm), that overwhelms the system, occurs.

       Design storm criteria for sizing runoff treatment facilities exists in the HRM. The "Water Quality Design Storm" is defined by the HRM in terms of recurrence interval and all of the runoff treatment BMPS are designed to treat the water quality storm. But they are different for eastern and western WA, and also vary depending on BMP type (flow –based vs. volume-based BMPs).

    c. Determine which receiving bodies, if any, may be receiving stormwater discharge.

3. Evaluate the effect of the stormwater on the baseline conditions of the receiving waterbodies.

    In a general manner, assess how stormwater discharge affects the receiving water baseline. While the pollutant concentration of the influent (i.e., runoff flowing into the BMP) may not always be known, or what the actual pollutant concentrations of the effluent (i.e.. discharges from the stormwater outfall) will be, we can look at how the project is expected to change the baseline - how much net-new pollution generating impervious surface is being added, how much of that is being treated, and how much existing impervious surface is being treated through project related retrofits. If a project is retrofitting to provide treatment to existing untreated impervious surface, the project may actually result in a net improvement of the water quality, thus decreasing the exposure to the fish and the risk to the species.

Use the following calculation for each pollutant category (i.e., TSS, dissolved metals, oil, and phosphorus) to assess on how much stormwater treatment of existing untreated impervious surface, if any, may be necessary to maintain the annual pollutant loading baseline:

Annual effluent pollutant load = influent pollutant load – (pollutant load reduction achieved from infiltration + pollutant load reduction achieved from runoff treatment)

If the annual effluent pollutant load is greater than zero, retrofit of existing impervious surface would be necessary to achieve the no-net increase in loading standard.

To calculate the *influent pollutant load*: multiply the acres of *net-new impervious surface created* by the *loading figures* from the "Mean load from Untreated surfaces" column in Table 1 to calculate the *influent pollutant load*.

The *pollutant load reduction achieved from infiltration* figure would be calculated using information calculated by MGSFlood and reported on the ESA checklist.

The *pollutant load reduction achieved from runoff treatment* figure would be calculated based upon BMP effectiveness averages. Calculate this using the figures in the "Mean load from treated surfaces based on mean BMP effectiveness" column in Table 1. by multiplying the acres of *net-new impervious surface treated* (and, if applicable, *existing impervious surface retrofitted for runoff treatment*) by the *loading figures* from the "Mean load from treated surfaces based on mean BMP effectiveness" column in Table 1 to calculate the *pollutant load reduction achieved from runoff treatment*.

If the project results in a net-increase in pollutant load, then the fish may face an increased exposure to the pollutants. Exposure will depend on species presence, amount and location of discharge to the receiving water and the assimilation capacity of those receiving waters. However, it is important to recognize that that not all storm events will result in a discharge to receiving waters.

The larger faster flowing systems can generally assimilate and dilute higher concentrations of pollutants and flows without adversely effecting fish. Conversely smaller volume and slower flowing systems won't have as great an assimilation and dilution capacity. Receiving waterbodies with low pollutant levels, below CWA aquatic life standards will assimilate pollutants s with out resulting in an adverse effect to fish. Also, the effects of discharges to highly degraded receiving waters may not measurably impact baseline receiving water conditions.

b. Evaluate the effect of the BMPs on peak flow, flow durations, in-stream base flows, and potential for in channel effects such as scour or down-cutting. Flow control is intended to minimize erosive flows in the channel and thus reduce adverse impacts to fish from channel erosion (e.g., increased turbidity, down-cutting, washing away or covering spawning gravels, etc.). Generally speaking, BMPs that discharge to receiving waterbodies will not help in-stream base flows to the same degree that BMPs which infiltrate runoff or retain runoff verses just detaining and releasing. However, depending on the nature of the receiving water and/or baseline land conditions in the basin, and the position of the project in the watershed, this may not necessarily result in an adverse effect either (e.g., direct discharges to flow control exempt waterbodies, projects located in floodplains above high seasonal groundwater or bedrock, etc.). Also, in instances where there are significant time delays in flows from the upper reaches of the watershed, direct discharges in lower reaches of the watershed may actually help reduce high in-stream flows. BMPs that discharge runoff into dispersion areas, "leaky runoff treatment BMP's" (e.g., ecology embankments, swales, vegetative filter strips, constructed treatment wetlands, wet ponds etc.) and infiltration systems (e.g., infiltration ponds, trenches, and vaults), will help maintain the natural hydrology. Detention-type BMPs (e.g., detention ponds and vaults), while mitigating adverse impacts from peak-flow, may significantly lengthen flow durations and/or reduce in-stream base flows. Again, the relative size of the discharge to the size (volume) of the receiving water will help determine the extent, if any, to which stormwater flows effect the receiving waterbodies.

5. Determine what the effect of the stormwater is on listed species.

a. Evaluate the listed species occupying the receiving waters – determine what species there are, what the run timing is, what the use of the system is – spawning, rearing, etc. Find out what the residual rate for Chinook is – in other words when are the fish likely to be there and in what life stage form are they present at what time of year. The goal is to determine if the fish may be present when runoff discharge occurs.

b. Using the change in the baseline in the receiving waters and the presence or absence of listed fish information, determine what effect the runoff discharge may have on fish. Remember that if there are no fish present at the time of the runoff discharge, there will be no direct effects to the species. However, there may still be some indirect effects to prey species, but that will depend on the species, when it may be preyed upon, and the time of year the effects may occur.

Level Three Stormwater Consultations:

Projects that will result in significant increase in pollutant loading or unattenuated flows into natural systems. These projects will typically create significant amounts of new impervious surface, create new roads, or will occur in watersheds with degraded baselines which support runs which are at risk and the project discharges to waterbodies in which listed fish are present and have the potential to be exposed to the adverse effects of the runoff. The analysis will be very detailed.

Standard: Projects which fit under this level of consultation will result in measurable adverse effects to listed species and/or critical habitats due to the stormwater runoff associated with the creation of new impervious surface.

BA Content:

Project Description and Baseline Information:
Include the same information as described for the Level Two Analysis
However, if the project is creating a new road, and thus there is no existing impervious surface, the information in Exhibit 431-4 of the Environmental Procedures Manual (EPM) should be used to determine what the current annual pollutant load is from the existing land uses (This will become the baseline stormwater to compare the project impacts too.). Note that the pollutants from untreated and treated runoff are reported as mean annual loads and may or may not be an accurate representation of the runoff from the project area – a caveat should be included.

Effects Analysis
Include the same analysis as described for the Level Two Analysis: However, rather than address runoff effects at a watershed- or project-level scale, it may be necessary to complete the analysis on a threshold discharge area (TDA) basis. This level of analysis may be useful if impacts may vary by receiving waterbodies (i.e. some receiving bodies may be impacted from the runoff discharge and others will not). In addition, complete the annual pollutant loading modeling.

Modeling pollutant load from the new impervious surface may be required to determine the pollutant loading from the new impervious surface. The model currently used by FHWA and WSDOT is the FHWA model that is found in the EPM Exhibit 432-4. This model provides annual pollutant loads and not concentrations. The Services have been using the Kayhanian model, but WSDOT has not been able to validate this model for Washington State. (FHWA, WSDOT and the Services will continue their discussions on the best model to use.) Do not forget to factor in load reductions due to infiltration via stormwater conveyances and “leaky” BMPs.

Also, consider modeling for downstream effects such as modeling for the dilution of the stormwater effluent at the outfall in a receiving waterbody. The following model is available: Ecology's dilution model RIVPLUM5 at http://www.ecy.wa.gov/programs/eap/mixzone/app6-1/pwspread.html. This model will provide information on how far the stormwater discharge plume would extend into and downstream from the outfall and what the dilution factor would be. Additional information can be obtained by using Ecology's Reasonable Potential Analysis (REASPOT.XLS) and LIMIT.XLS spreadsheets on Ecology's Web site at http://www.ecy.wa.gov/programs/eap/mixzone/app6-1/pwspread.html. Ecology provides the spreadsheet to help NPDES permittees determine the potential for their discharges to cause water quality problems and to calculate effluent limits. On the web page Ecology states: "*The spreadsheets REASPOT.XLS, and LIMIT.XLS determine reasonable potential (to violate the aquatic life water quality standards) and calculate effluent limits. The process and formulas for determining reasonable potential and effluent limits in these spreadsheets are taken directly from the Technical Support Document for Water Quality-based Toxics Control, (EPA 505/2-90-001)."*

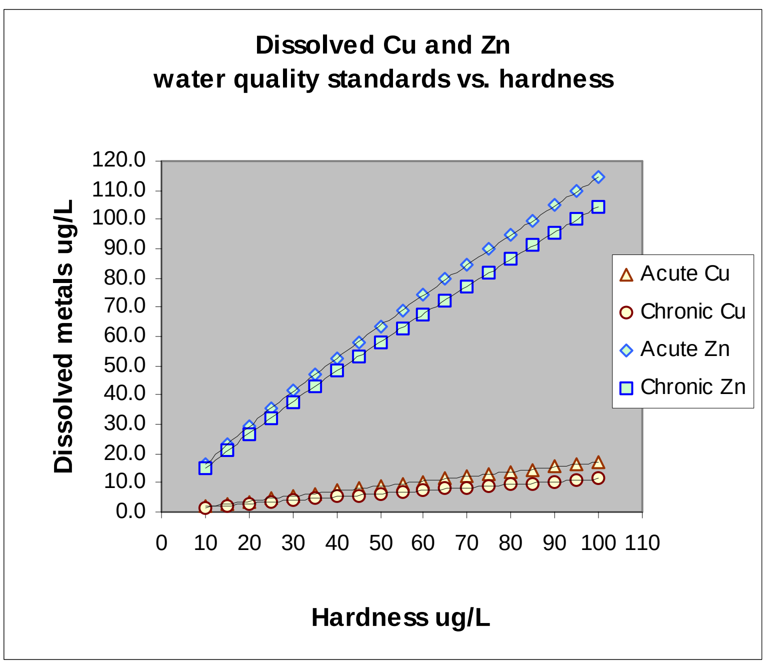
NOAA has suggested modeling for first-flush releases of pollutants from the BMPs. WSDOT monitoring data from stormwater BMPs in western Washington indicates that the dirtiest input and output from the BMP's is not during a first-flush storm, but during the month of March. Thus first-flush modeling is not appropriate for western Washington State.

Additional analysis on the effects of pollutants on listed species may be required. There is currently very little information available about what concentrations of dissolved copper and zinc may result in effects to listed fish species. Based on laboratory studies, NOAA has recently identified 5ug/l as the copper level of concern for fish. At this point, this level is based largely on unpublished data and analysis. The only other available standards are the Clean Water Act (CWA) Standards, and these standards may change as more research is conducted.

Both the copper and zinc CWA standards are dependant on the hardness of the water and measured in terms of acute (short-term) and chronic (longer-term exposure). The CWA standards for a number of different water hardness's are shown in Table 1. To use the table the hardness of the receiving water must be known. Groundwater contains more minerals (e.g., calcium and magnesium) and thus is harder than rainwater. The difficulty will be to determine what the hardness of the water is at the time the metals enter the receiving body – especially if there is no water quality monitoring data for such occurrences. The harder the water (i.e., ground water fed systems in the summer), the higher the concentration of the discharge can be and still meet CWA standards. Runoff is expected to be softer when discharges from BMP's occur during the rainy season.

Table 1: Copper and Zinc Water Quality Standards

Hardness	Acute Cu	Chronic Cu	Acute Zn	Chronic Zn
		ug/L		
10	1.9	1.6	16.3	14.9
15	2.8	2.2	22.9	20.9
20	3.7	2.9	29.3	26.7
25	4.6	3.5	35.4	32.3
30	5.5	4.1	41.3	37.7
35	6.3	4.6	47.0	42.9
40	7.2	5.2	52.7	48.1
45	8.0	5.7	58.2	53.1
50	8.9	6.3	63.6	58.1
55	9.7	6.8	69.0	63.0
60	10.5	7.3	74.2	67.8
65	11.3	7.9	79.4	72.5
70	12.2	8.4	84.6	77.3
75	13.0	8.9	89.7	81.9
80	13.8	9.4	94.7	86.5
85	14.6	9.9	99.7	91.1
90	15.4	10.4	104.7	95.6
95	16.2	10.9	109.6	100.1
100	17.0	11.4	114.4	104.5



“Acute conditions” are changes in the physical, chemical, or biologic environment which are expected to result in injury or death to an organism as a result of short-term exposure to the substance or detrimental environmental condition.

“Chronic conditions” are changes in the physical, chemical, or biologic environment which are expected to result in injury or death to an organism as a result of repeated or constant exposure over an extended period of time to a substance or detrimental environmental condition.

“Hardness” means a measure of the calcium and magnesium salts present in water. For this purpose hardness is measured in milligrams per liter and expressed as calcium carbonate ($CaCO_3$)